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Air Pollution Control Programme 2010

The Finnish National Programme for the implementation of Directive 2001/81/EC, approved by the Government on September 26, 2002

HELSINKI 2002

MINISTRY OF THE ENVIRONMENT

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The Finnish Environment 588e
Ministry of the Environment
Environmental Protection Department

Lay-out: Seija Malin
Photo: Juhani Seppovaara/Kuvaliiteri

ISSN 1238-7312
ISBN 952-11-1292-1 (nid.)
ISBN 952-11-1293-X(PDF)

Edita Prima Ltd

Helsinki 2002

PREFACE

The Directive (2001 / 81 / EC) of the European Parliament and the Council on national emission ceilings for certain atmospheric pollutants entered into force on November 27, 2001. This "Emission Ceilings Directive" gives each Member State maximum emission levels for certain pollutants responsible for acidification, eutrophication and ground-level ozone in the Community Area which must be observed from 2010 onwards. To implement the directive, each Member State must draft a national programme to reduce their own emissions, which includes the estimated emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x), ammonia, and volatile organic compounds (VOCs) in 2010, and information on plans and action affecting these emissions.

A working group set up by the Ministry of the Environment on March 27, 2002 prepared a draft for the Finnish National Programme. The working group was made up of Seppo Sarkkinen (Chairman) and Pasi Iivonen (Secretary) both from the Ministry of the Environment, Timo Ritonummi from the Ministry of Trade and Industry, Risto Saari from the Ministry of Transport and Communications, Marjaana Vainio-Mattila from the Ministry of Agriculture and Forestry, Heikki Sourama from the Ministry of Finance and Pia Forsell (Permanent expert) from SYKE (the Finnish Environment Institute). The programme is based on the data from the National Climate Strategy. Kari Mäkelä from VTT (Technical Research Centre of Finland) produced emissions calculations and estimates for the working group. In summer 2002, the working group received over 30 comments on its draft programme, which were used to draw up the final proposal.

The Government approved the programme at a plenary session on September 26, 2002, in accordance with section 26 of the Environmental Protection Act, and the proposal was also discussed by the cabinet financial committee. The programme obliges various authorities to take the necessary action to put it into effect and to monitor the implementation of the programme within their own sectors.

The Finnish National Programme can be found on the Ministry of the Environment website. The Ministry of the Environment is responsible for providing information about the programme, so that the monitoring process can be as effective as possible and a revision procedure can be carried out before the end of 2006, if necessary.

The programme was drafted in Finnish and translated to Swedish before the Government approved it. This unofficial translation was made from the Finnish language version.

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Summary

The Directive of the European Parliament and the Council on national emission ceilings for certain atmospheric pollutants entered into force on November 27, 2001. The Directive gives the Member States set maximum limits for certain pollutants, which cannot be exceeded as of 2010. These emission ceilings apply to sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs — with the exception of methane) and ammonia (NH_3). Sulphur dioxide, nitrogen oxides and ammonia cause acidification. Nitrogen oxides and volatile organic compounds contribute to ground-level ozone formation. Emissions from nitrogen oxides and ammonia cause eutrophication. There is a significant link here between the source point of emissions and the area affected by emissions, unlike greenhouse gases, for instance.

Estimates of emissions of sulphur dioxide, nitrogen oxides, ammonia and volatile organic compounds in Finland in 2010 and information on plans and actions which affect them have been compiled by a working group within the Ministry of the Environment, with representatives from the Ministry of Finance, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications and the Ministry of Trade and Industry. The working group also received information on estimates, models and scenarios from experts at the Finnish Environment Institute and the Technical Research Centre of Finland.

The working group estimates that Finland will be able to fulfil its obligations through air pollution control measures already adopted or envisaged. As a consequence, Finland's National Programme on the implementation of the directive consists largely of a description of adopted and envisaged measures, and an overview of the implementation of Community legislation that will soon come into force. If the projected emission trends hold true, no further measures will be needed. The National Programme and its follow-up routines will verify the trends. The Ministry of the Environment is responsible for the follow-up routines and any adjustments that may be needed in 2006.

This National Programme has been drawn up for approval by the Finnish Government on the basis of the working group study and the comments it has received thereon. The National Programme comprises measures for reducing emissions from energy generation, transport, agriculture and industry, and also actions to reduce emissions from non-road machinery and equipment, recreational craft and small-scale combustion by wood-burning fires and stoves.

Obligations under the Emission Ceilings Directive

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The Directive of the European Parliament and the Council on national emission ceilings for certain atmospheric pollutants entered into force on November 27, 2001 (2001 / 81 / EC, henceforth the Emission Ceilings Directive). The Directive gives the Member States set maximum limits for certain pollutants, which cannot be exceeded as of 2010. These emission ceilings apply to sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs — with the exception of methane) and ammonia (NH_3). Nitrogen oxides refers to nitric oxide (NO) and nitrogen dioxide (NO_2). Volatile organic compounds include all hydrocarbons and other organic compounds (except methane) whose vapour pressure is so high that they occur in gaseous form in normal outdoor temperatures. The Emission Ceilings Directive does not apply to emissions from international shipping or emissions from aircraft other than during the landing and take-off cycle.

The emissions regulated by the Emission Ceilings Directive and their impact are closely linked. Sulphur dioxide, nitrogen oxides and ammonia cause acidification. Nitrogen oxides and volatile organic compounds contribute to ground-level ozone formation. Emissions of nitrogen oxides and ammonia cause eutrophication. There is a significant link here between the source point of emissions and the area affected by emissions, unlike greenhouse gases, for instance.

The national emission ceilings that have been set will, broadly speaking, attain the interim environmental objectives set at the Community level for acidification and ground-level ozone, and help reduce soil eutrophication. Emission ceilings will also improve air quality and reduce airborne nutrient loads to water. The aim is to reduce environmental impact and people's exposure to air pollution throughout the EU. These problems are a source of both environmental and health problems and are closely interlinked; by examining them together, we can ensure that a harmonized and cost-effective solution can be found for each of them. Member States are free to choose the most cost-effective way to fulfil their obligations under the Emission Ceilings Directive. Implementation of the Directive will ensure that sulphur dioxide emissions within the EU (EU-15) will fall to one quarter of the present volume by 2010, while emissions of nitrogen oxides and volatile organic compounds will be halved and ammonia emissions fall only by about 20 per cent of their 1990 volumes.

The emission ceilings have been set so as to reduce the impact of emissions throughout the EU. A calculation model was used to find the most cost-effective way of cutting down emissions to a level which will allow the environmental objectives to be attained. Calculation took into account transboundary pollution, the sensitivity of the environment and human exposure to pollutants, and also the technical feasibility of the planned measures and their costs. The measures tested through the calculation model are technological methods of reducing emissions, not structural changes based on economics.

When the Emission Ceilings Directive was being prepared, calculations were made for the reduction of emissions to ensure that the objectives for the abatement of acidification and ground-level ozone can be attained throughout the EU by 2010. The starting point was an estimate of the 1990 emissions level and information on existing and proposed Community acts (December 1998), and also national legislation and strategies. An analysis was made of the additional measures needed and their costs with the aim of keeping total costs within the EU area as low as possible. Based

on the analysis, individual emission ceilings were then set for each Member State. The analysis showed that Finland should be able to attain its obligations through adopted and envisaged measures.

Emission ceilings for Finland, 2010:[1)]

	Emission ceiling 2010kt/a	Emissions 1990 kt/a	Reduction attained 1990/2000	Reduction aim 1990/2010
Sulphur dioxide	110	260	72%	57%
Nitrogen oxides	170	287	26%	41%
ammonia	31	38	13%	18%
Volatile organic compounds	130	224	28%	42%

The table above shows the data and estimates of Finland's emission ceilings for 2010, emissions in 1990 and the reduction in emissions between the reference year and the target year. More precise estimates of emissions from transport were obtained during the preparation of the programme, and this has caused considerable changes in the total emission levels. This should be borne in mind when comparing emission estimates in this programme with figures given previously. The more precise calculations have been included both in the actual emissions figures and projections of future trends in emissions.

According to Article 6 of the Emission Ceilings Directive, Member States shall, by October 1, 2002 at the latest, draw up programmes for the progressive reduction of national emissions of pollutants with the aim of complying with the national emission ceilings laid down in Annex I by 2010. These programmes shall include information on adopted and envisaged policies and measures and quantified estimates of their effect on emissions in 2010. Any significant changes anticipated in the geographical distribution of national emissions shall be indicated. The programme must be made available to the public and sent to the Commission.

[1] Estimates of the nitrogen oxides and VOC emissions in 1990 and 2000 differ from figures previously reported by Finland, as the new figures now include the latest calculations on emissions from transport, provided by the Technical Research Centre of Finland (LIISA 2001.1).

Starting point and general situation in Finland 2

2.1 Air pollution control planning

Since the mid-1980s, national programmes and plans for air pollution control in Finland, especially the reduction of acidifying emissions, have been prepared by four committees (committee on sulphur I, 1986; committee on nitrogen oxides, 1990; committee on sulphur II, 1993; and the committee on acidification, 1998). A national study of acidification (HAPRO) conducted and funded by the Ministry of the Environment and the Ministry of Agriculture and Forestry in 1985-1990 also provided a good foundation for further planning.

On a number of occasions, the above committees stressed the importance of cost-effectiveness in choosing and timing measures, and in cutting emissions, whether through administrative instruments under the environmental legislation, or voluntary action by businesses themselves. Economic incentives have also been applied to promote air pollution control, for instance, certain investments related to air pollution control were exempted from VAT, catalytic converters were exempted from car tax, and differential tax on traffic fuels was introduced.

Air pollution control has been on the agenda since the 1980s, starting with the protocols of the Convention on Long-Range Transboundary Air Pollution of the Economic Commission for Europe (ECE). Finland has ratified all air pollution control protocols currently in force. After Finland's accession to the European Union in 1995, air pollution control has continued to evolve alongside the increasingly stringent Community legislation on the subject.

2.2 Sulphur dioxide emissions

Sulphur emissions to the air have fallen significantly in Finland during the 1980s and 1990s. National programmes to reduce sulphur emissions, set by the Government, contributed considerably to the good results. A Government resolution was issued in 1986 for a 50 per cent reduction of sulphur emissions on the 1980 level, and in 1990, the aim was set at an 80 per cent reduction over the next ten years.

In the interest of implementing the plans made by the first and second committee on sulphur, a Government resolution was issued based on the Air Pollution Control Act in force at the time, concerning limitations on the sulphur emissions from power stations, pulp mills, sulphuric acid plants and oil refineries, and limitations on the sulphur content permitted in coal and oil products. Investments, including about one billion Finnish markka for desulphurization units for existing coal-fired power stations, were made as early as the beginning of the 1990s, in order to implement these decisions. The sectoral reduction targets set for various industries have also been monitored and sometimes revised. Individual production plants which are required to have an environmental permit have their emission requirements laid down in their permit.

The national target of 80 per cent reductions on the 1980 level was also entered as Finland's commitment in the second sulphur protocol, signed in Oslo in 1994.

The target was attained the very same year. Sulphur dioxide emissions have continued to fall during the 1990s, by as much as 70 per cent since 1990, i.e. down to 73,500 tonnes in 2000. **The emissions ceiling for 2010 is 110,000 tonnes.**

Sulphur dioxide emissions according to reports of the Helsinki and Oslo protocols since the reference year1980, kt/a:

Sector/year	1980	1990	1995	2000
Energy generation (excl. housing and service buildings)		67.5 (power plants) 89.7 (industrial) 157.2	30.2 (power plants) 22.4 (industrial)52.6 52.6	25.4 (power plants) 30.2 (industrial) 55.6
Industrial processes		50.3	23.0	9.9
Heating for housing and service buildings		44.0	16.6	3.5
Transport		5.4 (road) 0.6 (other) 6.0	1.8 (road) 0.5 (other) 2.3	0.2 (road) 2.0 (other) 2.2
Non-road machinery (incl. farm machinery)		2.6	2.5	2.6
Total emissions	584	260.0	96.0	73.5

2.3 Nitrogen oxide emissions

Emissions of nitrogen oxides grew in Finland until about a decade ago, when they began to fall. The obligation under the 1988 Sofia protocol on reduction of nitrogen oxides emissions was that emissions should be reduced to below the 1987 level. Finland attained this target in 1992. In 1990, the committee on nitrogen oxides estimated that by 1998, emissions of nitrogen oxides could be cost-efficiently further reduced to a level corresponding to 15 per cent less than the 1980 level. In 1991, the Government issued its General Instructions on Restricting Emissions from Boilers and Gas Turbines. In 1988, a Government resolution on the reduction of emissions from transport was issued, and limitations for emissions were then given under the Road Traffic Act. A requirement for attaining these targets in practice was that new petrol-engined vehicles were fitted with 'three-way' catalytic converters as of 1991. Emissions from diesel-engined vehicles have been reduced both through innovations in engine construction and through after-treatment equipment. Emissions of nitrogen oxides have fallen by 25 per cent in Finland during the 1990s, to about 210,000 tonnes a year. **The emissions ceiling for 2010 is 170,000 tonnes.**

Emissions of nitrogen oxides since the Sofia protocol reference year (1987), kt/a:

Sector/year	1987	1990	1995	2000
Transport		145.1 (road) 10.5 (other) 155.6	112.1 (road) 10.9 (other) 123.0	80.2 (road) 15.8 (other) 96.0
Energy generation (excl. housing and service buildings)		41.8 (power plants) 21.1 (industrial) 62.9	33.9 (power plants) 30.7 (industrial) 64.6	29.5 (power plants) 39.7 (industrial) 69.2
Non-road machinery (incl. farm machinery)		49.5	34.5	32.8
Heating for housing and service buildings		13.6	8.8	8.2
Industrial processes		5.0	6.7	3.2
Total emissions	288.0	286.6	237.6	209.4

2.4 Emissions of volatile organic compounds

Emissions of volatile organic compounds in Finland began to fall in the 1990s. The obligation under the Geneva VOC protocol which was signed in 1991, i.e. a 30 per cent reduction on the 1988 level of emissions of volatile organic compounds by 1999, proved to be more difficult to attain in Finland than foreseen. The reasons for this are the trends in emissions from non-road machinery and equipment and, particularly, the fact that vehicles have not been replaced at the rate that was foreseen. Emissions from transport have been limited through strict emission limits applying to new vehicles since 1990. Emission requirements for vehicles have been made stricter on several occasions since then. Finland has also implemented the EC Directives on the control of volatile organic compound emissions resulting from the storage and distribution of petrol and emissions from industrial solvents. With the aid of differential taxes, there was a transition in Finland in the 1990s toward reformulated traffic fuels, which help reduce e.g. volatile organic compound emissions from petrol-engined vehicles and hydrocarbon and carbon monoxide emissions in exhaust fumes. Emissions of volatile organic compounds have fallen by close on 30 per cent during the 1990s, reaching about 160,000 tonnes a year. **The emissions ceiling for 2010 is 130,000 tonnes.**

Emissions of volatile organic compounds since the Geneva protocol reference year (1988), kt/a:

Sector/year	1988	1990	1995	2000
Transport	64.9 (road) 16.9 (volatile) 7.7 (other) 89.5	63.9 (road) 17.8 (volatile) 8.7 (other) 90.4	51.9 (road) 14.3 (volatile) 9.2 (other) 75.4	39.9 (road) 10.1 (volatile) 9.0 (other) 59.0
Solvent use	54.1	52.6	35.5	32.0
Industrial processes	28.6	26.5	23.8	16.4
Heating for housing and service buildings	27.5	27.6	27.4	27.7
Non-road machinery (incl. farm machinery)	15.6	17.0	16.4	16.1
Fuel distribution	7.6	7.7	7.4	4.0
Other	2	2	2	6
Total emissions	224.9	223.9	187.8	161.3

2.5 Ammonia emissions

Finland has not hitherto set reduction targets for airborne ammonia emissions, and consequently there has been no annual reporting duty on such emissions. Ammonia is, however, covered by the Multi-pollutant –Multi-effect Protocol (*the Gothenburg protocol)*, signed by Finland in 1999, although it has not yet entered into force. An estimated 85 per cent of ammonia emissions in Finland derive from livestock farming, 8 per cent from fur farms, 5 per cent from chemical fertilizers and about 1 per cent from forest industry processes. Both national and Commission estimates of ammonia emissions and abatement actions are vague concerning sectors other than the above, and information on ammonia emissions in other sectors and ways of reducing them may well have to be adjusted over the next few years. Ammonia emissions in Finland have fallen during the 1990s, partly as a result of water pollution control measures,

by a total of 10 per cent, reaching about 33,000 tonnes. **The emissions ceiling for 2010 is 31,000 tonnes.**

2.6 Cost-benefit of measures

Structural change in **energy generation and industry** brought down sulphur emissions a great deal in the early 1980s. The fall in sulphur emissions was brought about particularly by a drop in the use of heavy fuel oil, which is high in sulphur, for energy generation; a considerable fall in the production of sulphite pulp; discontinued use of iron ores high in sulphur; and air pollution control measures that were implemented at oil refineries and chemical plants. Investments in structural changes were admittedly expensive at the time, but they were primarily made for reasons other than air pollution control. The aim was to use long-term planning in a way which made it possible to carry out air pollution control measures in the context of production-related investments.

The structural changes did not have the same effect on nitrogen oxide emissions in the 1980s, but instead the total emissions remained unchanged as emissions from mobile sources increased.

Among the Government resolutions given in 1987, the sulphur emission limitations for coal-fired power stations caused the highest air pollution control investments. Some FIM 1,550 million (EUR 260 million) was spent on desulphurization units between 1987 and 1994, and this was crucial in reducing sulphur emissions by over 70 per cent on the 1987 level. It has been estimated that the cost benefit of these investments was about FIM 4,000-5,000 (EUR 700-800) per tonne of sulphur dioxide removed at plants operating at base loads, and FIM 6,000-12,000 (EUR 1,000-2,000) at plants operating at peak loads.

In 1991, the Government issued its General Instructions on Restricting Emissions from Boilers and Gas Turbines. In the early 1990s, about FIM 500 million (EUR 84 million) was invested in changing the combustion technology at power plants so as to reduce emissions of nitrogen oxides, and the cost per tonne of nitrogen oxides removed came to about FIM 3,000 (EUR 500).

At the end of the 1990s, the committee on acidification estimated that the most cost-effective measures available for the reduction of emissions from existing sources were already in use, and the main issues then became renewal of the motor vehicle stock and renewal of industrial and energy generation facilities.

Since the beginning of the 1990s, efforts to reduce emissions from **transport** have focused particularly on regulations concerning exhaust fumes, but also on fuel taxation.

Regulations concerning exhaust fumes have proved effective in the reduction of traditional air pollutants such as hydrocarbons and nitrogen oxides. Emissions per vehicle have fallen by over 90 per cent compared with the beginning of the 1970s.

Technological developments in mobile emission sources and their fuel requirements are subject to international regulations and competition within the sector. In the preparation of the EU regulations on emissions, for instance, trends in emission regulations in the USA and the automobile industry's views on technological development potential have been taken into account, in order to ensure the cost-benefit of measures. In 1997, IIASA estimated that the cost of reducing emissions of nitrogen oxides from petrol-engined cars by using 'three-way' catalytic converters would come to FIM 16,000 (EUR 2,700) per tonne of nitrogen dioxide. Similarly, the technology required by the Euro III emissions requirements for heavy diesels, which entered into force in 2000, was estimated to cost about FIM 24,000 (EUR 4,000) per vehicle. Relatively high total costs arise from air pollution control measures concerning road transport and non-road machinery compared with those from point sources, but the former are very important in terms of improving local air quality. It can be anticipated that after the implementation of limitations on emissions from vehicles

which have already been decided in the European Union (EURO IV and V), measures to reduce traditional pollutants such as nitrogen oxides and hydrocarbons will focus primarily on fuels, structural aspects of transport and the volume of transport.

Taxation of transport fuels is the biggest source of environmental tax revenue in Finland. In 1990, a general differential tax on fossil fuels was introduced. Taxation of petrol was differentiated so that no additional tax was payable on unleaded petrol. Unleaded petrol then rapidly attained a very big market share. In 1993, the tax on transport fuels was further differentiated on the basis of environmental aspects so that the tax on reformulated petrol and sulphur-free diesel oil was lowered. There is reason to believe that the tax differentiation on transport fuel has had considerable effect in displacing the more environmentally hazardous grades on the market.

The tax on the purchase of motor vehicles has not so far been focused on environmental grounds in Finnish or EU legislation. Finland introduced a reduction in vehicle tax for catalytic converters in 1991. The intention was to encourage people to replace their old cars with new ones fitted with catalytic converters. At the same time, however, Finland entered a deep economic recession and sales of new cars plummeted to a mere quarter of the sales in 1990 — in fact, car sales still have not fully recovered (see Figure 5). The effect that the catalytic converter tax reduction had in boosting renewal of the motor vehicle stock has not been calculated.

The main aim of environmental protection measures in **agriculture** has been protection of water courses, but the measures in question are also effective in reducing ammonia emissions. Measures were stepped up as a result of EU membership.

The agri-environmental support system for 2000-2006 contained within the horizontal rural development programme is a continuation of the agri-environmental programme for 1995-1999. Its main emphasis is on general measures and additional supplementary measures. The supplementary support focuses on implementing precise environmental measures based on agreements between the Government and individual farmers. The total funding for the new agri-environmental support system for the programme period 2000-2006 is EUR 1.7 billion, with EU funding accounting for 56 per cent. The total funding for agri-environmental support, both general and supplementary measures, in 2001 was EUR 250 million. Some 91 per cent of farmers are committed to the system and it covers 96 per cent of the field area. Funding for supplementary support agreements comes to a total of about EUR 37 million, of which 10 per cent focuses on improving the effectiveness of fertilizer use. In 2000, supplementary support payments came to a total of EUR 32 million. Out of that sum, about 5 per cent, i.e. over EUR 1.4 million, focused on improving the effectiveness of fertilizer use.

The effects of the new system for agri-environmental support have been estimated, and as far as ammonia is concerned, for instance, it is thought that it may reduce emissions of ammonia to the air by 15-20 per cent. Since there is not yet enough monitoring data available, it is difficult to say whether the estimated effects will materialize.

The growth in **real GDP** appears to have become separated from the trend in emissions of sulphur dioxide, nitrogen oxides and volatile organic compounds to the air (Figures 1 and 2). Ammonia emissions are linked mainly with agriculture. A similar separation between trends in agricultural GDP in the 1990s and ammonia emissions is not in evidence.

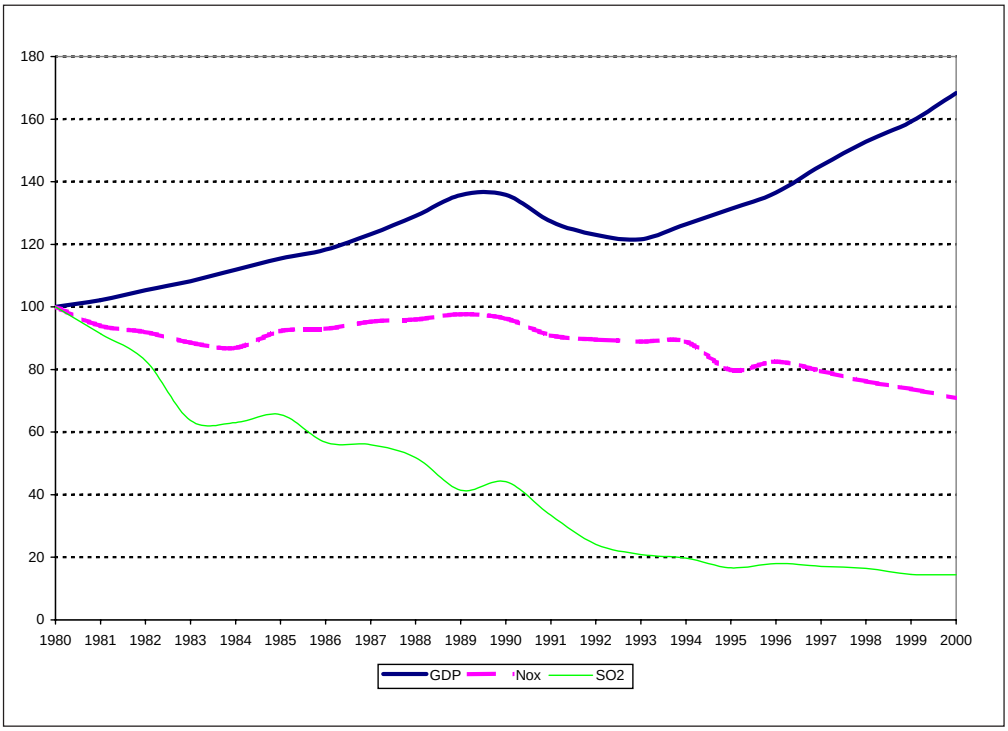

Figure 1. Real GDP and emissions to the air of sulphur dioxide and nitrogen oxides (1980 = 100, GDP according to 1995 price level). Source: Statistics Finland/Ministry of the Environment, Finland´s natural resources and the environment, 2001.

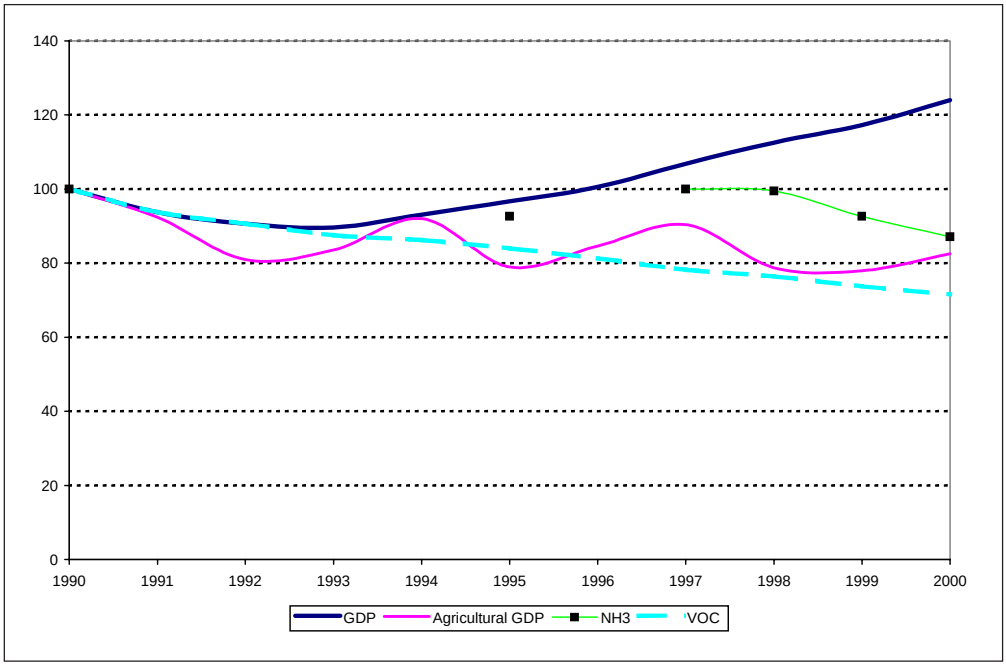

Figure 2. Real GDP, agricultural GDP, and emissions to the air of volatile organic compounds and ammonia (1990 = 100, GDP according to 1995 price level). Source, for GDP: Statistics Finland/Ministry of the Environment, Finland´s natural resources and the environment, 2001; source for agricultural GDP: oral information from Statistics Finland; SYKE report on VOC and ammonia emissions.

3 Plans for reducing emissions

3.1 General criteria and basic assumptions

Finland can meet the obligations set out in the Emission Ceilings Directive by implementing other Community acts that are already in force or that will be put into effect in the near future, and national plans and strategies that have already been approved. This programme incorporates these measures together with other known undertakings and plans aimed at reducing emissions that would be put into effect irrespective of the Emission Ceilings Directive. If the existing measures are sufficient to cut emissions as planned, implementing the directive will not require any additional reduction measures. This National Programme will ensure that emissions can be cut as envisaged.

Assumptions presented in this programme are made on the same basis as the estimates on population trends, economic growth, changes in economic structures, economic instruments, technology, and other change factors used in planning and monitoring the National Climate Strategy.

Forecasting the growth in emissions is primarily done on the basis of calculations made as part of the assessment of the environmental impacts of the National Climate Strategy. However, for some sectors more up-to-date information has been used. The biggest revisions are in road transport emissions, which are made on the basis of the national LIISA 2001.1 calculation model, and non-road machinery, for which the VTT-maintained TYKO calculation system (updated on November 15, 2001) has been used. A separate VTT report from January 2002 assesses the prospects for emissions by recreational craft.

The National Climate Strategy will have its greatest impact on emissions in energy generation. The implementation of the exhaust emissions provisions incorporated in Community legislation will be the main factor helping to lower emissions in the transport sector. Stricter Community legislation will also substantially reduce emissions by non-road machinery and recreational craft. Continuous updating of Community legislation, measures and programmes at national level, and structural changes in different sectors will have a more general impact on emissions.

3.2 Energy generation

Energy generation as a source of emissions

Energy generation, including industrial combustion processes, accounts for 60 per cent of all Finnish sulphur dioxide emissions, while more than 20 per cent of all nitrogen oxide emissions in Finland originates from large energy-generating plants. However, energy generating plants are only a minor source of volatile organic compounds and ammonia. Sulphur dioxide emitted in connection with energy generation processes originates in the sulphur contained in fuels, which are usually in the form of coal, oil products or peat. The amount of NO_x emissions primarily depends on the combustion technology used, as combustion air is the main source of nitrogen. The energy sector makes its investments on a long-term basis, which means that they will have an impact on emissions for many years to come.

Climate strategy

The purpose of the National Climate Strategy (www.ktm.fi), which the Finnish Government presented to Parliament in March 2001, is to enable Finland to cut its greenhouse gas emissions in accordance with the obligations set out in the Kyoto Protocol and the EU's internal burden-sharing agreement (reduction of greenhouse gases to 1990 levels by 2008-2012). An environmental impact assessment was carried out in conjunction with the Strategy so that its environmental effects could be determined (see www.ymparisto.fi).

Energy generation, including industrial combustion processes, is a major contributor to greenhouse gas emissions in Finland. Unless significant reductions are achieved, there is a danger that greenhouse gas emissions, especially carbon dioxide emissions caused by the use of fossil fuels, will increase in the future. The Climate Strategy contains a number of measures aimed at cutting greenhouse gas emissions. According to the Strategy, the Programme Promoting Renewable Energy Sources drawn up in 1999 and the Energy Conservation Programme from 2000 (for both, see www.ktm.fi) should be put into effect in their entirety. It also calls for less reliance on coal and for replacing it with natural gas or nuclear power, or a combination of both.

All these measures incorporated in the National Climate Strategy will either reduce the amount of energy generated (i.e. produce savings) or help to promote methods that produce less carbon dioxide, and consequently, less sulphur (renewable energy sources, natural gas and nuclear power).

According to the environmental impact assessment made for the National Climate Strategy, implementing the Strategy would cut sulphur dioxide emissions from the Finnish energy generating sector by about 30 per cent by 2010, compared with a scenario in which the Strategy was not adopted (Figure 3). In nitrogen oxide emissions the difference would be about 20 per cent.

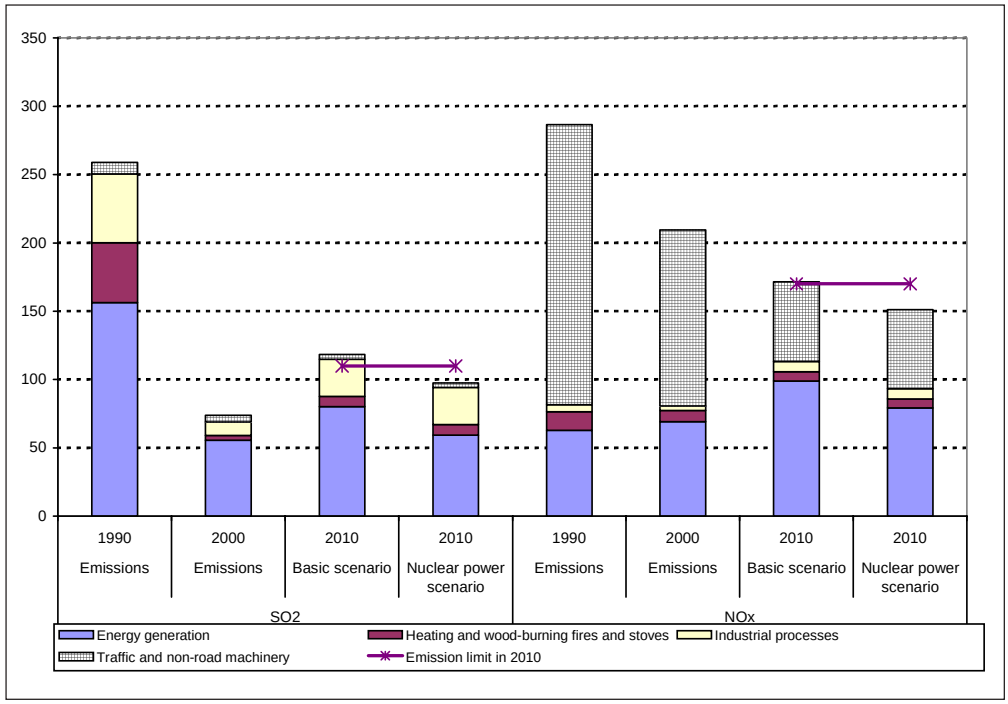

Figure 3. Acidifying emissions (SO_2 and NO_x) in Finland (kt) in 1990, 2000 and 2010 for two different scenarios. The estimates are from the environmental impact assessment made for the National Climate Strategy, though the figures for road transport and non-road machinery are based on the latest available data.

Kyoto mechanisms and the Emissions Trading Directive

According to the National Climate Strategy, the Kyoto mechanisms should supplement measures taken at national level, but it did not quantify them. The mechanisms enable project-specific measures carried out outside Finland (Joint Implementation or JI, and Clean Development Mechanisms or CDMs) or emissions trading to be used for emissions credits. In October 2001, after the work on the National Climate Strategy was complete, the European Commission submitted its own proposal for a directive on trading in greenhouse gas emissions in the EU. It is based on a plant-specific allocation of emission rights and its timetable and implementation mechanisms differ from those set out in the Kyoto Protocol.

If Finland decides to make extensive use of the Kyoto mechanisms and especially if the obligatory emissions trading incorporated in the proposed directive becomes reality, Finland may not have to implement all the measures proposed as part of the National Climate Strategy. Theoretically, this might also result in lower-than-envisaged cuts in sulphur and nitrogen oxide emissions in energy generation. For example, there is a possibility that if coal-fired power stations were included in emissions trading, less use would be made of national measures aimed at cutting output.

Any use of the Kyoto mechanisms, particularly the implementation of the emissions trading directive, could lead to a situation where actual emissions would be closer to the baseline scenario. This would in turn make it necessary to revise the environmental impact assessment made for the National Climate Strategy. However, the changes would probably be of a minor nature, as in a statement attached to the decision in principle in favour of building additional nuclear power capacity in Finland made on May 24, 2002, Parliament requested the Government to take controlled measures to reduce the use of coal in electricity and heat generation. The Ministry of Trade and Industry has appointed a committee that should present its proposals for the necessary measures by the end of 2003. Limiting the use of coal would help to keep the resulting NO_X and especially SO_2 emissions under control. At the same time, a number of surveys show that the introduction of emissions trading, as incorporated in the proposed directive, would lead to substantial cuts in the use of peat.

EU Member States cannot use joint implementation, emissions trading or other Kyoto mechanisms when putting the Emission Ceilings Directive (2001 / 81 / EC) into effect. Neither can a Member State offset a lower-than-required reduction of one acidifying emission with larger-than-expected cuts elsewhere.

Large combustion plants

Electricity and heat generation in combustion plants with fuel power of more than 50 MW is the most important source of sulphur dioxide emissions and a major source of nitrogen oxides. A directive covering such plants came into effect in November 2001 (2001 / 80 / EC). It is the first document that sets out Community level emission ceilings for plants that have received operating licences before July 1987, and it also tightens the limits for sulphur dioxide and nitrogen oxides emitted by new plants. Existing plants will have to be in compliance with the directive's provisions by the end of 2007, and from the beginning of 2016 some of the provisions will be tightened still further. Emission ceilings and other obligations set out in the directive will apply to new plants after the directive has come into force (December 2002). The directive overlaps with the Emission Ceilings Directive and will help to harmonize air pollution control measures at energy generation plants in different Member States. However, its implementation might in principle also make the Emission Ceilings Directive less cost-effective.

The directive will be put into effect by tightening and updating national emission ceilings on power plants and boiler plants. Existing combustion plants (i.e. those that

have received operating licences before July 1987) can, however, have national emission reduction plans which allow individual plants to deviate from the ceilings set out in the directive. Such plans must be binding and comprehensive, even though a plant earmarked for decommissioning can under certain conditions be excluded. Any plan must be submitted to the Commission by November 2003. In Finland, studies are under way on using reduction plans as an alternative to emission limit values.

More efficient energy use

The implementation of the Energy Conservation Programme included in the National Climate Strategy would reduce energy consumption by 4-5 per cent by the year 2010, from the levels that would be achieved without any new measures. The Programme includes such measures as developing and commercializing energy-efficient technologies, economic instruments, making more efficient use of Government regulations, energy-conservation agreements, and improving energy analyses and reviews. To make the Programme more effective, new energy taxes and Government funding providing incentives for energy conservation are also included. Most Government money will go to developing new technology, supporting energy-conservation agreements, energy repairs in buildings, and provision of information.

The Energy Conservation Programme and the Programme Promoting Renewable Energy Sources will be reviewed in autumn 2002 as part of the process of implementing and improving the National Climate Strategy. In this context, consideration will also be given to the statement on energy conservation that Parliament added to the National Climate Strategy and the decision in principle in favour of building additional nuclear power capacity.

Voluntary energy-conservation agreements already cover 80 per cent of electricity generation and industrial energy use in Finland. There are plans to expand the system to such areas as residential buildings.

Economic instruments for energy generation

Economic instruments in the field of energy generation comprise energy taxation, production subsidies and investment grants. Since 1997, fossil fuels and peat used for generating heat have been subject to a tax that is primarily calculated on the basis of carbon dioxide emissions. Energy generation is not taxed but energy use is subject to a consumption tax. Electricity generated using renewable energy sources is entitled to subsidies, and power plants using domestic energy can receive discretionary investment grants. These instruments are primarily intended to cut carbon dioxide emissions but they also help to reduce the emissions of sulphur dioxide and nitrogen oxides. As stated in the National Climate Strategy, energy taxes and subsidies will be used for promoting energy conservation and the use of renewable energy sources, while at the same time, consideration will be given to the competitiveness of Finnish industry and to global trends.

Incorporating the emissions trading arrangements proposed in the emissions trading directive into other economic instruments is being studied. It is clear that energy generation cannot be subjected to emissions trading and present levels of energy taxation at one and the same time.

However, there is no need to abolish the present system of taxation and subsidies in sectors not covered by the emissions trading arrangements.

3.3 Transport

Road transport as an emissions source

According to the basic scenario presented in the National Climate Strategy, there will be an increase in total traffic in Finland by 2010, while at the same time, the emissions of sulphur dioxide, nitrogen oxides and volatile organic compounds generated by the transport sector are expected to go down. Traffic in Finland has grown much more slowly than in many other EU Member States, and since the mid-1990s, economic growth has actually exceeded the increase in traffic volumes (Figure 4).

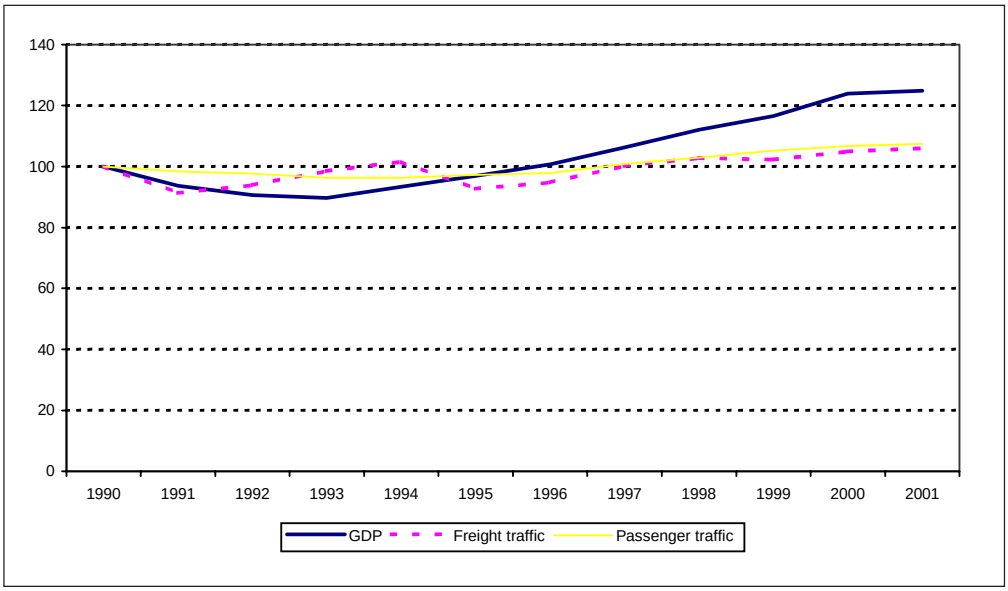

Figure 4. Traffic volumes (kilometrage in passenger and freight traffic) and real GDP in 1990-2001 (1990 = 100, GDP at 1995 price levels).

Within the transport sector, road transport is the most important source of nitrogen oxides and hydrocarbons (and also of volatile organic compounds), while ships account for most of the sulphur dioxide emissions.

Provisions on vehicle exhaust emissions

Tightening the provisions on vehicle exhaust emissions has traditionally been the most efficient way of reducing exhaust emissions generated by traffic. As required by Community legislation, binding emission limits for new vehicles in different categories have been agreed on, and EU-wide emission ceilings for new cars with catalytic converters went into force in 1993. The existing EURO III requirements, introduced in 2000, limit emissions of carbon monoxide, hydrocarbons, nitrogen oxides and particles.

Provisions on exhaust emissions from cars and vans will be tightened in 2005, with the introduction of the new EURO IV requirements. These will cut vehicle-specific emissions of hydrocarbons and nitrogen oxides for petrol-driven cars and vans by half of their present levels, while at the same time, the emissions of diesel-powered vehicles will be reduced by almost as much.

The introduction of the EURO IV requirements in 2005 and EURO V requirements in 2008 mean that provisions on exhaust emissions from diesel-powered heavy goods vehicles will be tightened twice by 2010. EURO IV requirements will cut hydrocarbon and nitrogen oxide emissions generated by heavy goods vehicles by almost one third of their present levels. Under EURO V requirements on the other hand, there will be no further cuts in hydrocarbon emissions by heavy goods vehicles, but they will reduce nitrogen oxide emissions by more than 40 per cent.

Fuel quality

Quality requirements for vehicle fuels are defined at Community level in a European Parliament and Council directive (98/70/EC). Under the directive, fuel quality requirements will be further tightened in 2005 when, for example, the maximum permissible sulphur content in both petrol and diesel oil will be set at 50 ppm (at present the limits are 150 ppm and 350 ppm, respectively).

Efforts are under way to change the directive so that the maximum permissible sulphur content would be lowered still further, to 10 ppm. The aim is to replace sulphur-rich grades with such sulphur-free fuels in the EU by the year 2010. Finland is considering the option of changing over to sulphur-free fuels in one go in 2005.

Reductions in fuel sulphur contents will make catalytic converters more efficient and will also help to cut the already low sulphur emissions generated by road transport still further. The primary aim is, however, to make it possible to introduce vehicle technology that helps to achieve substantial reductions in emissions of small particles and nitrogen oxides, and makes vehicles more fuel-efficient and, consequently, reduces carbon dioxide emissions.

Provisions on petrol volatility help to regulate the amount of volatile hydrocarbons emitted by vehicles. The introduction of an environmentally based fuel tax in the 1990s enabled Finland to put onto the market petrol grades that are less volatile than the grades used elsewhere in the EU. This, together with the gradual modernization of the country's motor vehicle stock, helped to cut Finland's VOC emissions by one third during the decade. In 1999 they totalled 11 kilotons.

The Emission Ceilings Directive does not apply to international sea transport. Nevertheless, as about 20 per cent of Finland's sulphur dioxide emissions are generated by ships, it is important to reduce the sulphur content of marine fuels. The International Maritime Organization (IMO) approved the air pollution annex of the international MARPOL 73/78 Convention (Annex VI) in its conference in London in 1997, in which context the Baltic Sea was defined as a Special Area where fuels should not contain more than 1.5 per cent of sulphur. The Annex can only be put into effect if a sufficient number of IMO members ratify the document and so far there have only been 5 ratifications (of the 15 required). An additional requirement is that the ratifying countries' combined merchant shipping fleets must constitute at least 50 per cent of the world's fleet. The Finnish Government has submitted the Annex to Parliament for ratification, and the decision is expected during the first half of 2003. The Baltic Marine Environment Protection Commission (HELCOM) has also approved the 1.5 per cent limit for sulphur content in ship fuels. The European Commission has begun drafting a proposal for an amendment to the directive 1999/32/EC under which the provision would also apply to heavy ship fuels. The Commission is likely to submit its proposal in autumn 2002.

Economic instruments in the transport sector

Vehicles

At the moment, the average age of cars in Finland, 10.4 years, is the highest in the EU. As the motor vehicle stock is getting older and as modernization makes only slow progress, tighter provisions (EURO III-V) will only have a slow impact on emissions. Figure 5 shows that sales of new vehicles reached their peak in the late 1980s just before the catalytic converter became a standard component in petrol-driven cars. The reduction scenario for transport-generated VOC and NO_x emissions used in this programme is based on the assumption that a total of 140,000 new cars are sold every year in Finland. This would mean that by the year 2010 practically all cars in Finland would have a catalytic converter. However, the fact that Finland probably has to relax rules on imports of second-hand cars in accordance with the EU's internal market legislation may slow down the process. The danger is that Finns could start

bringing in big cars that, apart from generating larger amounts of traditional exhaust emissions, would also produce more carbon dioxide. Therefore, it is important that when changes are incorporated in the Finnish system of traffic taxes and charges, sufficient account is taken of the National Climate Strategy target of providing tax incentives for fuel-efficient vehicles. In other respects too, taxes on road transport should be based on economic instruments linked to emission levels.

Under the directive on end-of-life vehicles, the last owner of the vehicle can deliver it for scrapping at no cost. Member States should introduce this provision by July 1, 2007, but as part of the national implementation procedure, Finland is studying the possibility of putting it into effect in 2003.

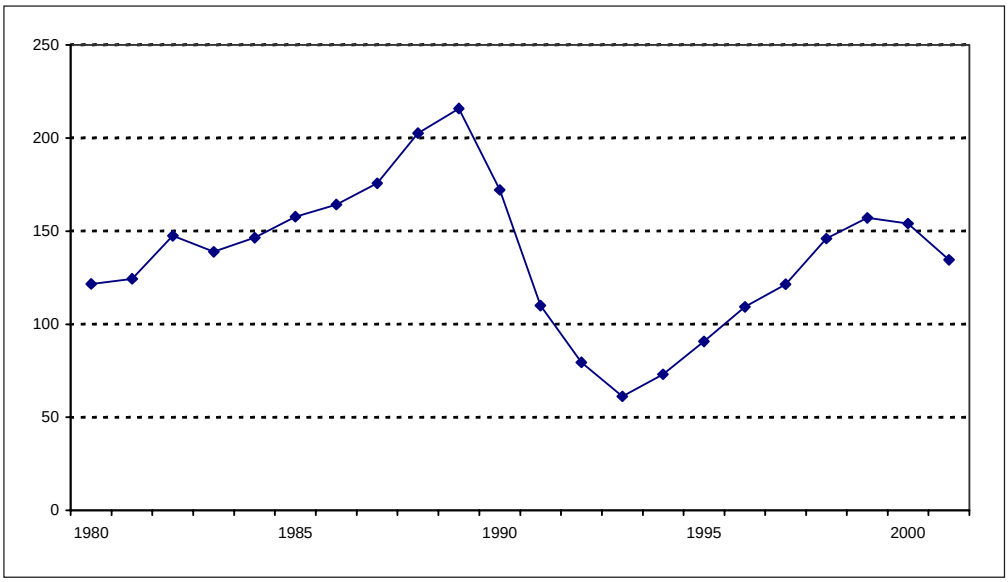

Figure 5. Registration of new vehicles (1,000) in 1980-2001.

Shipping

Sweden has introduced a system of progressive harbour dues, which is based on both the sulphur content of the fuel grades and nitrogen oxide emissions generated by the vessels. The new arrangements have already had an impact on the sulphur dioxide and nitrogen oxide emissions generated by shipping between Finland and Sweden. Under the Baltic Sea Protection Programme approved by the Finnish Government in summer 2002 (see www.ymparisto.fi), municipalities should introduce a similar system of port charges graded in accordance with environmental loading in Finland, too. Even though international shipping is not covered by the Emission Ceilings Directive, progressive harbour dues would help to lower airborne nutrient loads and acidification in water areas caused by shipping emissions.

Air transport

At the moment, Finland is trying to determine how to grade air transport charges so that the environmental effects of aviation could be reduced as efficiently as possible (the most serious pollutants in this respect are noise, and greenhouse gas and nitrogen oxide emissions). Progressive air transport charges would make it easier to reach the targets set out in the Emission Ceilings Directive.

The European Commission is preparing a general framework for transport infrastructure charges that would take into account external transport costs. This would provide a basis for charge systems in all modes of transport. The grading of air transport charges in accordance with noise emissions is also being discussed in the EU. Any EU acts would naturally have an impact on decisions made in Finland.

Environmental steering in the transport sector

In 1994 the Finnish Ministry of Transport and Communications introduced an action programme to reduce the environmental impacts of the transport sector that covers all modes of transport. In 1999, the Ministry introduced revised transport guidelines in environmental matters that are based on the ISO 14001 standard (see www.mintc.fi). The programme presents Finland's international obligations and the targets incorporated in the national environmental policy as they apply to the transport sector. The agencies and companies in the administrative sector of the Ministry also have their own environmental programmes.

The aim of the transport sector environmental programme is to achieve vehicle emission levels that help to keep environmental loads below the limits that are critical from the point of view of acidification and health effects. The most important means of reducing emissions presented in the programme are provisions on exhausts, international strategies and their implementation, transport planning, provisions on vehicle inspection, implementation of the international air pollution annex of the MARPOL Convention that covers emissions generated by shipping, by 2003, development of equipment for the recovery of volatile hydrocarbons generated in oil terminals and tankers, electrification of railways, and research and development. Furthermore, both the transport sector environmental programme and the National Climate Strategy contain recommendations on the promotion of training in fuel-efficient driving habits, voluntary energy conservation agreements, and the use of information technology as a replacement for physical mobility.

Promoting public transport

Promoting public transport is a major element of the national transport policy, and major investments in rail transport are especially important from the point of view of air quality targets. In Finland, public transport's share of passenger traffic has remained more or less constant, and in order to make it more competitive and popular, a new public transport strategy has been prepared under the auspices of the Ministry of Transport and Communications. The document (see www.mintc.fi) was finalized in December 2001.

The main aim of the strategy is to make public transport more attractive so that its market share will not drop below present levels. This can be achieved by making services more efficient, safe and obstacle-free, and by improving their quality. At the same time, improvements and better maintenance of the infrastructure can provide public transport with a better operating environment. Combined journeys can be made easier and the flow of journeys smoother by providing better information on public transport and by setting up public transport interchanges. Walking and cycling should also be integrated into public transport systems.

Promoting walking and cycling

A new national cycling programme (see www.mintc.fi) drawn up under the auspices of the Ministry of Transport and Communications was finalized in February 2001. It replaced an earlier programme from 1993, which has been a subject of regular monitoring aimed at determining how well its targets can actually be met. The aim of the new programme is to double the amount of cycling in Finland by 2020 from its 1989-99 levels and at the same time improve the safety of cycling in line with overall road safety targets. Improving the quality, attractiveness and safety of cycling, and providing it with a better status in the eyes of decision-makers at government and municipal level are the qualitative targets of the programme. Another aim is to fully integrate cycling and public transport into smooth and safe journeys.

The first national walking programme (see www.mintc.fi) drawn up under the auspices of the Ministry of Transport and Communications was finalized in March

2001. The central aim of the programme is to promote walking alongside other modes of transport so that its supporters can get a fair hearing when transport-policy decisions and plans are made, and to ensure that walking can become more popular as a daily mode of transport. The programme incorporates a general target of promoting walking, cycling and public transport so that their combined share of all modes of transport will grow and that both society at large and individual citizens can become less dependent on the private motorcar.

The programmes for promoting cycling and walking and the public transport strategy form a basis for practical measures to increase the market share of sustainable modes of transport. The Government, local authorities, operators and non-governmental organizations have already launched pilot projects in municipalities to promote them. By involving itself in regional transport system planning and by providing project funding in accordance with memorandums of understanding concluded with local authorities, the Government is contributing to municipal undertakings aimed at promoting public transport and non-vehicular traffic.

Freight transports

Efforts to improve the logistic efficiency of freight transport and minimize transport needs are also aimed at reducing emissions generated by freight transport. Developing combined transport operations, logistics research and applications, and developing short-sea shipping can make it easier to achieve the targets. The Ministry of Transport and Communications is cooperating closely with transport operators and their representatives so that more environmentally friendly and efficient solutions can be found.

Emissions by the transport sector

During the period 1990-2010, nitrogen oxide emissions by the transport sector are likely to drop by about 73 per cent (110,000 tonnes), while the sector's VOC emissions are expected to be reduced by 77 per cent (more than 50,000 tonnes). This is primarily because of more stringent provisions on road traffic exhaust emissions (Figure 6). If all shipping emissions are taken into account (i.e. also emissions by international shipping), the decline in transport sector NO_X and VOC emissions would be 54 and 67 per cent, respectively.

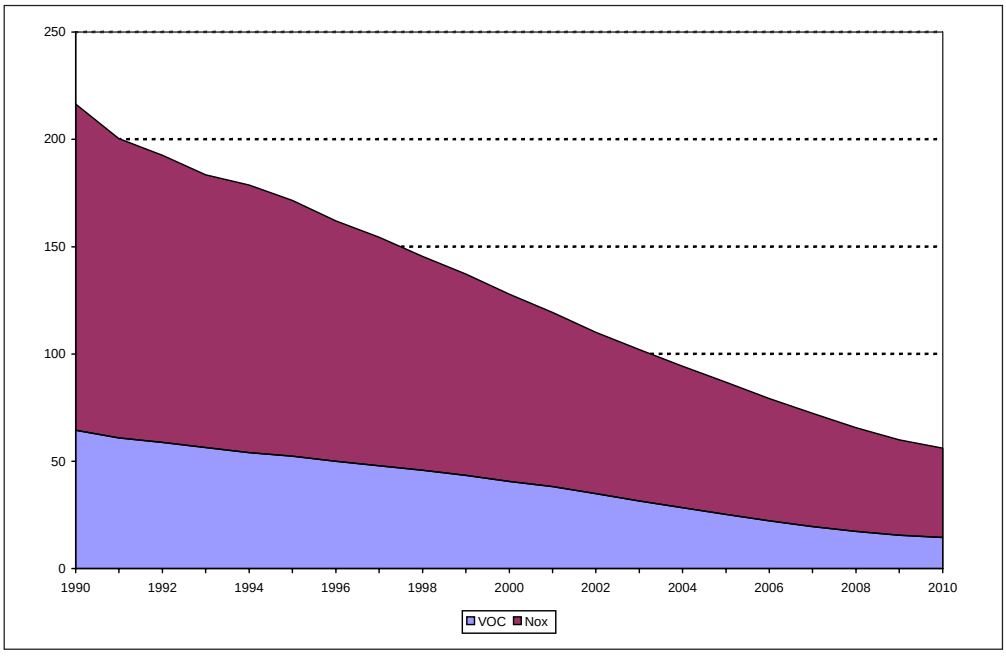

Figure 6. Transport sector's NO_x and VOC emissions (kt) (road, air and rail transport) in 1990-2010.

3.4 Non-road mobile machinery and recreational craft

Even though the emissions by diesel-powered non-road machinery are similar in composition to those generated by heavy lorries and can be reduced using the same methods, the problem has only been tackled very recently. Action is needed because non-road mobile machinery has been the fastest-growing source of emissions, particularly in the field of VOC and NO_x. Under the directive on emissions by non-road mobile machinery, the first stage of the regulations was introduced in 1998, and by 2003 Finland will have put into effect the second stage for all engine sizes (19-560 kW). The EU also aims to introduce emissions provisions corresponding to the EURO IV requirement for heavy vehicles, before the year 2010.

Provisions on the emissions of and fuels used by diesel-powered non-road mobile machinery will have their greatest impact on the emissions of sulphur and nitrogen oxides and small particles.

Non-road machinery (incl. agricultural machinery) produced about 20 kilotons of hydrocarbons in 2000, most of which was generated by machinery powered by petrol engines of less than 19 kW, such as lawn mowers and chain saws. The European Union is finalizing a directive that incorporates gradually tightening certification provisions, which will cut hydrocarbon emissions generated by mobile machinery to a few kilotons over the next 10-20 years. Most of the actual reductions will not take place until the next decade, however.

There are about 85,000 snowmobiles in Finland, and at the moment they are not subject to any national or EU-imposed emission limits. Most of the world's snowmobiles are produced in the United States and Canada, and Finland is the only European country with snowmobile manufacturing. Thus, Finland should keep a close eye on the preparation of emission ceilings in the USA so that harmonized snowmobile emission limits could be incorporated in the EU directive on non-road mobile machinery.

Finnish recreational craft generated an estimated 8 kilotons of hydrocarbons and 1 kiloton of nitrogen dioxide in the year 2000. The number of recreational craft in Finland is expected to grow still further, though at the same time there is a clear shift from 2-stroke engines to 4-stroke engines with lower emissions and fuel consumption. VTT estimates that this alone will cause carbon dioxide emissions to drop by one third in the long run.

The European Parliament and Council are discussing a proposal for a directive under which recreational craft engines taken into use in 2005-2006 would be subject to exhaust gas and noise limits. In the calculations used as a basis for the directive it is generally assumed that the limits might reduce hydrocarbon emissions by existing petrol engines to one tenth of their present levels. There would also be big cuts in hydrocarbon and nitrogen oxide emissions of diesel engines.

If implemented, the new emission ceilings would reduce hydrocarbon emissions of Finnish recreational craft to about 1 kiloton in 10-20 years, while carbon monoxide emissions of boat engines would be cut by half. The limits would have no impact on nitrogen oxide emissions and it should also be noted that the directive would have its greatest impact on emissions after 2010. In addition to engine technology, fuel quality also has an effect on the emissions generated by recreational craft, which can be quite substantial locally.

3.5 Agriculture

Agriculture as a source of emissions

In 1999, the estimated greenhouse gas emissions by Finnish agriculture were more than 20 per cent lower than in 1990. The emissions have dropped because livestock

numbers have gone down and less fertilizer is used. Structural changes (Figure 7) and more efficient production have contributed to the fall in the number of livestock (Figure 8). A decline in the number of farms and an increase in their size are also signs of the structural changes under way in Finnish agriculture.

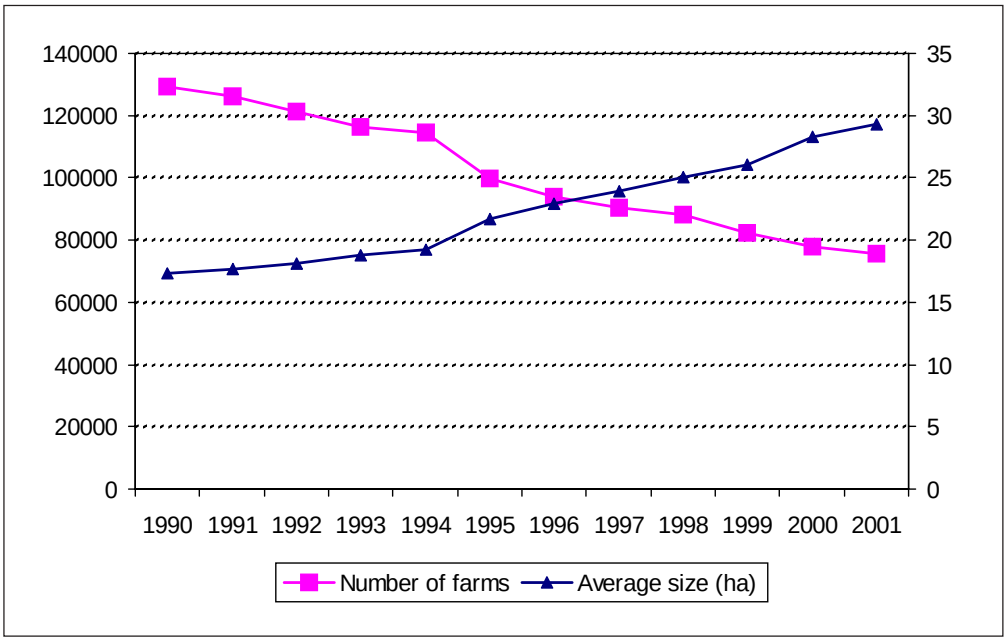

Figure 7. Changes in the number of farms and average area of arable land in 1990-2001. Included are farms with more than 1 ha of arable land (MTT Taloustutkimus 2002).

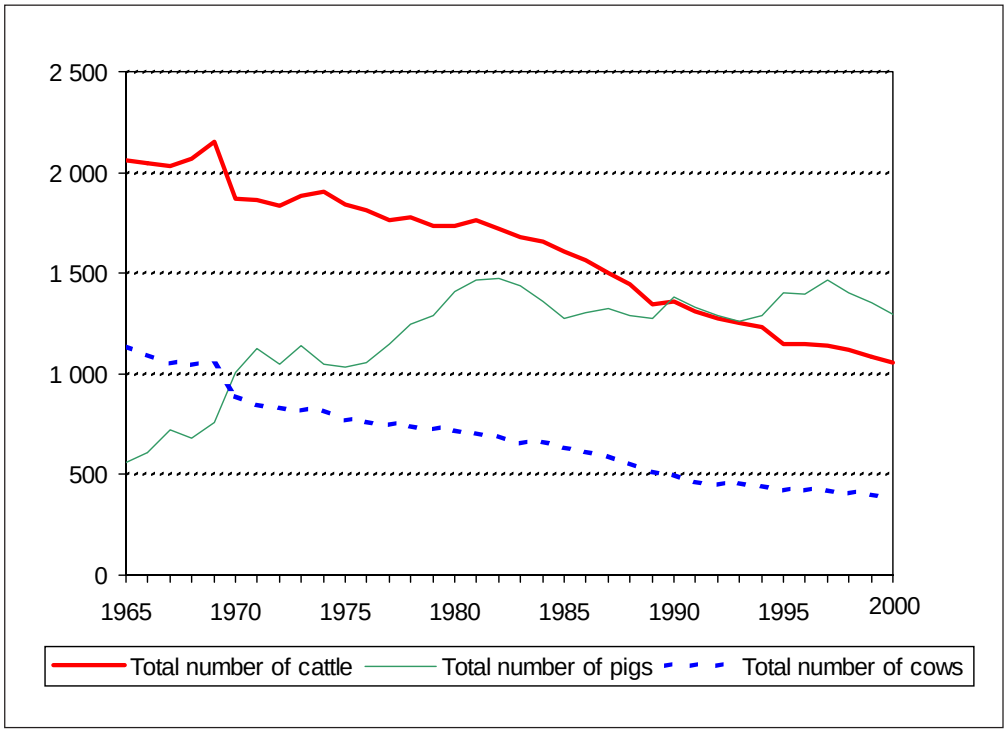

Figure 8. Changes in livestock numbers (1,000 animals) in 1965-2002 (Maatilatilastollinen vuosikirja 2002)

There has been a steady decline in agricultural ammonia emissions in Finland during the last 20-25 years, as livestock numbers have dropped and the way manure is processed has changed. In recent years, more efficient use of feed protein has also helped to reduce ammonia emissions. Nevertheless, agriculture remains by far the biggest source of ammonia emissions in Finland.

Agri-environmental support system

The purpose of the voluntary agri-environmental support system is to reduce air and water pollution caused by agriculture. As a result of structural changes in Finnish agriculture, the number of farms involved (active farms) in the system has dropped significantly. In 2000 it was 80,000 or 20 per cent lower than in 1995. Active farms have an average size of 28 arable hectares.

The voluntary agri-environmental support system which is partly funded by the EU has been applied in Finland since 1995. The first programme period covered the years 1995-1999, while the second, which started in 2000, will end in 2006. It is based on Council (EC) Regulation No 1257 / 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF). During both programme periods, the emphasis has been on the reduction of water pollution caused by agriculture. Measures required by the support system have, however, simultaneously helped to promote air pollution control.

Agri-environmental support is divided into environmental support all farmers are entitled to and special subsidies requiring more efficient environmental protection and management measures. Environmental support intended for all farmers incorporates a system in which a farmer commits himself to carrying out all basic measures and one voluntary additional measure for five years.

As a basic measure, a livestock farmer must pay close attention to manure nutrients in connection with fertilization, make every effort to spread the manure during the growing season and to compost all manure not spread on the fields. There is also a provision prohibiting the use of animal manure for surface fertilization of grassland after August 31 unless the manure is worked in or the field ploughed immediately after spreading. The purpose of the ban is to reduce ammonia evaporation.

Reduction of ammonia emissions generated by manure storage facilities at livestock farms and recovery of manure gases are two of the additional measures that have an impact on ammonia emissions. In 2000, a total of 5,500 Finnish farms chose to apply them. Ammonia emissions generated by a manure storage facility can be reduced by housing it in a roofed structure or by using an approved cover that prevents the ammonia from evaporating. Manure gases can also be recovered using different types of filter or in biogas plants jointly run by farmers. A farmer wishing to promote the well-being of his livestock should also keep a nutrient balance sheet so that the problems generated by an oversupply of proteins can be minimized.

The voluntary special subsidy agreements are also aimed at reducing ammonia emissions by making manure use more efficient. One way of doing this is to allow a farm to receive manure from another farm. A total of 5 per cent or 100,000 ha of the arable land in Finland is covered by this arrangement.

The Government decree 931 / 2000 introduced to put the EU nitrate directive (91 / 676 / EEC) into effect**,** specifies limits for the use of nitrate fertilizers and nitrate contained in animal manure. The provisions have been drawn up with water pollution control in mind, but they also have an impact on the amount of substances emitted in connection with agricultural processes, such as ammonia. The decree recommends that manure be worked in within four hours of its spreading, which can substantially reduce ammonia emissions.

A working group appointed by the Ministry of Agriculture and Forestry has studied the predicted growth in greenhouse gases generated by agriculture up to the year 2020, as part of the National Climate Strategy. Agricultural policy decisions and

the above-mentioned measures, such as the agri-environmental support system, investment aid, the nitrate directive and the Environmental Protection Act will help to reduce greenhouse gas emissions generated by agriculture and also ammonia emissions.

Potential for reducing ammonia emissions

As Finnish soil is highly acidic, artificial fertilizers generate only a small amount of ammonia emissions. The only way to reduce ammonia emissions generated by artificial fertilizers is to cut the amount of fertilizer used. The amounts of nitrogen fertilizers already went down by about 25 per cent in the 1990s and lowering them still further to a significant extent would probably affect the amount and quality of the crops.

Reducing the nitrogen content of manure reduces ammonia evaporation in all stages of manure processing. The animal species and the breed, the physiological condition of the animal, and the feeding method used are some of the factors that have a significant impact on the nitrogen content of manure.

About two thirds of all ammonia contained in manure evaporates in animal sheds and during storage. More effective manure processing is the best way to control ammonia evaporation during these stages. Under the Environmental Protection Act, an animal shed requires an environmental permit that also covers the manure storage space and the manure processing taking place inside it. Reducing emissions in animal sheds requires substantial investments, and thus the necessary structural modifications can only be carried out in large animal sheds. The EU investment aid system, introduced in 1996, is aimed at making agricultural structures more efficient. In the 1990s, more than 16,000 Finnish farms received investment aid for the construction of manure storage space.

Working in the manure in connection with the spreading can also bring about a substantial reduction in ammonia emissions. Working the manure directly into the ground is an efficient way of preventing ammonia evaporation, but the lack of suitable technology means that the method is not in widespread use. Using peat as moisture absorbant and mixing it with liquid manure has also produced good results.

3.6 Industrial manufacturing processes

Sulphur emissions generated by industrial processes comprise about one third and nitrogen oxide emissions one tenth of Finland's emissions when the forest-industry's recovery boilers, which are an integral part of industrial processes, and energy generation at oil refineries, are included. In the future, sulphur emissions resulting from industrial processes are expected to remain below present levels, which are less than one third of 1990 emissions. Factors such as more efficient use of wood-based fuels in the forest industry will probably increase the nitrogen oxide emissions of Finnish industry to more than 10 per cent of total Finnish emissions by 2010.

Industrial processes generate one tenth of all Finland's emissions of volatile organic compounds. Technological progress and the use of substances with lower solvent content have helped to cut these emissions by about 40 per cent in the 1990s. Emissions caused by the use of solvents and other products containing volatile organic compounds have also dropped by 40 per cent in the 1990s, and now comprise one fifth of all emissions. These emissions will probably drop by another 20 per cent when the Government decree on limiting emissions caused by the use of industrial solvents issued in 2001 is put into effect.

About 3 per cent of all Finnish ammonia emissions come from the forest industry, and industry in general is expected to remain only a minor source of ammonia.

3.7 Wood-burning fires and stoves

At the moment, there are 2.2 million fireplaces plus about 1.5 million wood-fired saunas and boilers in Finland. Most fireplaces are used only occasionally. In 2000, wood-burning fires and stoves are estimated to have caused about 40 per cent of the country's emissions of airborne particles (less than 10 micrometers in size), almost half of its emissions of small particles (less than 2.5 micrometers in size), and almost one fifth of its emissions of volatile organic compounds. Moreover, in the same year, they are estimated to have generated more than 40 per cent of all airborn dioxin emissions of Finland.

In equipment used today, combustion conditions are rarely optimal from the point of view of air pollution control. According to the National Climate Strategy, the use of wood as heating fuel should be increased and, thus, it is proposed in the document that boilers using solid fuel should have emission limits so that methane emissions could be reduced. Such limits would also cut the emissions of other hydrocarbons.

The Ministry of the Environment has studied the possibility of introducing emission limits for new fireplaces, heating boilers and combustion devices using solid fuel. Carbon monoxide limits and minimum efficiency requirements may also be imposed on new fireplaces. It is believed that regulating carbon monoxide emissions generated during the combustion process will make it possible to keep emissions of particles and volatile organic compounds under control. Limits on particles and total hydrocarbons in boiler plants are also proposed. Carbon monoxide limits for small boilers (less than 50 kW) would be similar to those of fireplaces. Larger boiler plants would have to improve their efficiency and produce cleaner flue gases.

Nowadays, most fireplaces are installed in buildings during renovation and it is estimated that their sales will reach nearly 60,000 in 2002. Sales of wood-fired saunas will probably be almost as high. At the moment, about 40,000 wood-fired boilers a year are purchased for small buildings and 80 per cent of them are installed in old buildings during renovation. Emissions generated by wood-burning fires and stoves will probably remain at their present levels during the next few years, and after the introduction of new provisions they are likely go down. For the emissions generated by them to drop, it is essential to provide information about their correct use.

4 Impacts of the programme

4.1 Emissions impacts

By implementing the measures contained in the National Programme, emissions can be reduced to less than the obligations set for Finland for 2010. However, estimates of the impacts of the programme on emissions also include uncertainty factors in both the accuracy of the calculations and in the predictability of the impacts at a more general level.

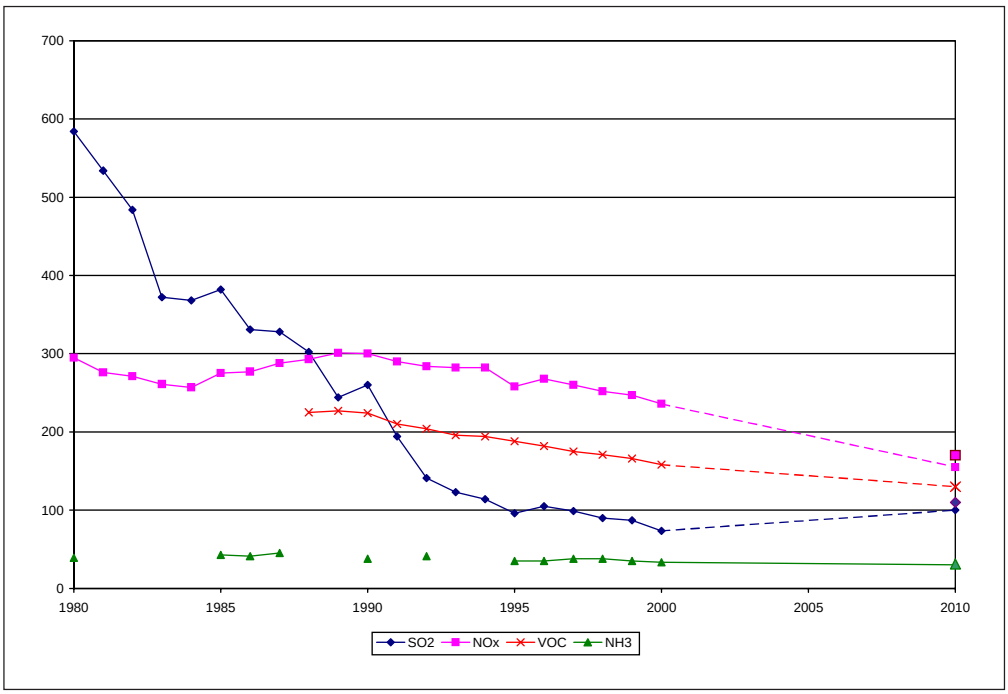

Figure 9. Sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonia emissions (kt/a) for the years 1980-2010 and emissions ceilings for 2010 (emissions for 2010 calculated using the IIASA RAINS model in line with climate strategy supplemented with latest information).

The basic assumptions of the programme follow the baseline data used in Finland's National Climate Strategy, drawn up in 2001, and the environmental impact assessment of the strategy. Estimates of future emissions are based on the calculations made for the preparation of the Emission Ceilings Directive, on data collected in environmental impact assessment of climate strategy and on the estimates of expert institutions in Finland.

During 1998, the Commission drew up obligatory targets for the Emission Ceilings Directive so that planned emissions reduction measures taken into account in the background calculations for the draft directive would be sufficient to achieve Finland's obligatory targets.

Following the completion of the draft directive, the European Parliament and the Council have approved a directive limiting certain emissions from large combustion plants.

Most of Finland's estimated reduction is based on the implementation of the existing Community legislation, particularly in the transport sector. The most important sub-sector is the tightening up of provisions on exhaust emissions from motor vehicles and other mobile sources. Another key factor affecting emissions consists of the expected changes in the Finnish energy generation industry.

Sulphur dioxide emissions (SO_2) currently total around 74 kilotons per annum (kt / a), i.e. one-third less than the obligatory target level[2] and will be about 10 kilotons less than the obligatory target level in the target year 2010, although the emissions vary from year to year according to the situation in the energy market. The most significant source of sulphur dioxide emissions is made up of energy generation and industrial combustion processes, where emissions will remain at current levels on the basis of environmental assessments of climate strategy, i.e. at a total of around 50-60 kilotons in 2010, as well.

Sulphur dioxide emissions associated with industrial processes will remain at current levels forming a significant source of emissions in the future, too. Other sources of sulphur emissions, such as heat and electricity generation for housing and service buildings, plus the contribution made by water transport and the use of non-road machinery will remain small and their overall impact is not expected to grow. The contribution made to sulphur emissions by international shipping is significant, but it is outside the area of application of the Emission Ceilings Directive.

Annual emissions of **oxides of nitrogen** (NO_x) are currently running at about 25 per cent above the obligatory target level (170 kt / a), but they will go down to 180 kilotons by 2005 and to an estimated 155 kilotons by the target year 2010[3]. The most significant source of emissions is the transport sector, particularly road transport, plus non-road machinery. According to latest VTT projections (summer 2002), tightening up of regulations on motor vehicle emissions and legislation on fuel inside the EU will reduce annual NO_x emissions in road traffic from the 1990 level (145 kt) by an estimated 110 kt by 2010. NO_x emissions from non-road machinery will also be reduced. On the basis of the environmental impact assessment carried out on Finland's climate strategy, increased use of fuel in energy generation will increase the sector's NO_x emissions by a maximum of 10 kt over the same period.

Annual emissions of **volatile organic compounds** (VOC) are currently around 25 per cent above the obligatory target level (130 kt), but they will be reduced to 150 kt by 2005 and to an estimated 130 kt by the target year 2010[4]. The most important source of emissions is the transport sector, especially road traffic. Other significant sources include small-scale fuel combustion, use of solvents and small items of machinery. According to latest VTT projections (summer 2002), tightening up of regulations on motor vehicle emissions and legislation on fuel inside the EU will reduce annual VOC emissions in road traffic from the 1990 level by an estimated 55 kt by 2010. VOC emissions by non-road machinery, and recreational craft will also be reduced. On top of this, the use of solvents in industry is also going to be reduced by 2010. The total quantity of emissions from the remaining sources will probably already have been reduced by 2010 to more or less under the earlier level as a result of Community legislation and national measures to limit emissions from small-scale fuel combustion.

Ammonia emissions (NH_3) are currently around 33 kt / a, i.e. already close to the obligatory target level (31 kt / a)[5]. The most significant source of emissions is livestock farming, but its contribution is expected to diminish in comparison with current

2 Calculated with the IIASA RAINS model using energy consumption figures according to the National Climate Strategy KIO2 scenario.

3 Calculated with the IIASA RAINS model using energy consumption figures according to the National Climate Strategy KIO2 scenario.

4 IIASA RAINS model calculation supplemented with national emissions figures.

5 Calculated with the IIASA RAINS model.

levels as the number of animals goes down, manure treatment methods develop and utilization of feed proteins improves. Applying the agri-environmental support system and the Nitrate Directive will underpin measures to reduce ammonia emissions.

4.2 Costs and benefits

Cutting Finland's own emissions still has an important role in reducing the hazardous impacts caused by pollutants in the air. However, about 80 per cent of sulphur compounds, over 60 per cent of nitrogen oxides and roughly half the atmospheric ammonia fallout, plus a considerable amount of ground-level ozone and suspended atmospheric particles come to Finland in the form of long-range transboundary pollution. This highlights the importance of international cooperation from the perspective of cost effectiveness and reaching targets. In Finland, volatile organic compounds are not the most critical factor from the point of view of the formation of ozone.

As well as cutting emissions nationally, Finland has been emphasizing the importance of influencing other countries in Europe, especially Finland's neighbouring areas, since the early 1980s. In practice, negotiations have been going on over the drafting of protocols under the Convention on Long-range Transboundary Air Pollution and bilateral agreements made with Estonia and Russia.

The starting point for planning the emissions ceilings for each country defined in the Community legislation, i.e. the reference scenario, was the adopted and envisaged policies and measures in the EU legislation, plus known national legislation and implementation of national strategies. In addition to these, any necessary additional measures were targeted at different countries numerically so that their cost effectiveness would be as high as possible at the Community level. An estimated 80 per cent of the costs of the reference scenario at Community level are made up of measures aimed at road transport.

During 1998, the Commission drew up background calculations for the Emission Ceilings Directive and on this basis, the adopted and envisaged emissions reduction policies and measures used as the starting point in the draft directive would be sufficient to meet Finland's obligations. These policies and measures are incorporated in the National Programme.

Implementation of the Emission Ceilings Directive is not expected to involve Finland in any extra costs, because the emissions reductions called for by the directive will be realized as other existing obligations are met and plans put into effect.

In calculations carried out for the Commission, the realization of Finland's reference scenario was estimated to incur considerable expense. The basis for the revision was the 'energy market scenario' prepared for the 1997 energy strategy, the realization of which would have required the construction of more coal-fired energy generating capacity. In the Commission's calculations, purification technology costs are incurred by the existing emissions limits in Finland, consequently they were counted as reference scenario costs.

The Finnish Environment Institute has estimated the direct cost of measures to limit sulphur dioxide emissions in force in the sample selected year 1995 to total EUR 140 million. The Finnish Environment Institute also estimates the costs of limiting NO_x emissions from stationary sources to be approximately EUR 20 million for the sample selected year 1995. The most significant cost in limiting NO_x emissions and VOC emissions is associated with the acquisition of motor vehicles equipped with new purification technology.

There is some arithmetical uncertainty associated with estimating transport emissions data. The calculation method used in drafting the Emission Ceilings Directive differs from the Finnish national road transport emissions calculation system. Road transport emissions have a key role in determining the part played by

NOx and VOC in Finland's obligatory targets and in achieving them. VTT's latest estimates of the trend in Finland's road transport emissions have been used in assessing the impacts of the programme.

On the basis of impact assessments compiled for the Emission Ceilings Directive, the surface area of ecosystems subject to critical load by acidification in Finland would be reduced to about a quarter, i.e. from roughly 17 per cent to a good 4 per cent during the period 1990-2010. In 2010 there would thus be only an area of about 110 square kilometres still subject to acidification. Correspondingly, the surface area subject to eutrophication would be reduced from about 45 per cent to something over 13 per cent. Besides reducing acidification and eutrophication, the other important benefit is improvement in air quality. Air quality in built-up areas can be expected to improve because emissions reductions are going to be biggest in transport where the emission height is low and dilution is poor. Limiting emissions will reduce the direct health impacts caused by impurities in the air by lowering the concentrations of small particles, hydrocarbons and ozone. In all probability, target values for ozone based on health and environmental impacts will be exceeded by smaller and smaller amounts in Finland as both domestic loading and long-distance transboundary loading are reduced.

Approving, revising and monitoring the programme

5

5.1 Approving the National Programme

The programme has been drawn up by a working group set up by the Ministry of the Environment on March 27, 2002, with representatives from the Ministry of Finance, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications, and the Ministry of Trade and Industry. When the draft programme was circulated for comment, the working group received responses from 35 different bodies. The Government approved the programme at a plenary session on September 26, 2002 and the programme is being published and made available to the public so that they can provide the authorities with feedback on it.

5.2 Revising the National Programme

The Emission Ceilings Directive requires that national programmes should be revised as necessary and brought up to date by October 1, 2006. The Ministry of the Environment is responsible for revising the programme and will request the appropriate bodies to take part. If necessary, the Government will approve a revised programme.

5.3 Reporting emissions data

The Finnish Environment Institute draws up national emissions inventories for SO_2, NO_x, VOC and NH_3 emissions every year and updates emissions forecasts for 2010. By December 31, the Finnish Environment Institute provides the Commission and the European Environment Agency with final emissions inventories for the year preceding the year just ended, and preliminary emissions inventories for the year just ended.

The Finnish Environment Institute participates in the expert work of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the European Environment Agency's emissions inventory system (CORINAIR) which is developing guidelines to be applied in drawing up emissions inventories and projections.

5.4 Monitoring the National Programme

The Ministry of the Environment is responsible for monitoring the programme and revising it when necessary. In order to carry out monitoring, each ministry will draw up their own periodic evaluation of the implementation of the programme within their own sector and send it to the Ministry of the Environment. Sectoral assessments from the National Climate Programme may be used in the evaluation. Special attention will have to be given to monitoring the impacts of the Kyoto mechanisms and the possible adoption of emissions trading in the EU, the impacts of plans

complying with the directive limiting certain emissions from large combustion plants, and the renewal of the motor vehicle stock.

The success with which the programme is carried out will be evaluated on the basis of a summary report prepared by the Ministry of the Environment. The summary report will evaluate Finland's chances of being able to fulfil its emissions reduction obligations in line with the Emissions Ceiling Directive, and propose any further action that may be required. The Ministry of the Environment may set up a broad-based working group with the job of monitoring and reporting on the realization of the programme targets.

5.5 Contributing to international air pollution control development

Limiting acidification, eutrophication and the hazards caused by ground-level ozone in Finland calls, not only action within Finland itself, but also active measures within the European Union and other bodies. By taking part in the Clean Air for Europe (CAFE) project, and in preparatory work under the United Nations Economic Commission for Europe (ECE) Convention on Long-range Transboundary Air Pollution, the Ministry of the Environment and the Finnish Environment Institute will be influencing the development of air pollution control at the international level throughout the present decade. Action will be monitored and participation in such work will be integrated within the broad-based CAFE monitoring group set up by the Ministry of the Environment, which includes representatives from various authorities, research institutes and different interest groups. Other ministries, officials and national expert institutions will take an active part in international cooperation in the air pollution control field as the need arises.

Documentation page

Publisher	Ministry of the Environment
Date	October 2002
Author(s)	
Title of publication	Air Pollution Control Programme 2010, National Programme for the Directive (2001/81/EU), approved by the Government on 26 September 2002
Parts of publication/ other project publications	
Abstract	The Working Group, appointed by the Ministry of the Environment on 27 March 2002, was directed to prepare a proposal for the national programme for the progressive reduction of national emissions of certain pollutants. The the aim is to comply with the obligations given in the directive (2001/81/EY) by 2010 at the latest. The national programme includes information on policies and measures and quantified estimates of the effects of these policies and measures on pollutant emissions in 2010. The working group has put together the estimates on emissions of sulphur dioxide, nitrogen dioxide, ammonia and volatile organic compounds in 2010. Information from the National Climate Strategy has been used for the estimates. In addition, recent data on estimates, models and scenarios have been received from the Finnish Environmental Institute (SYKE) and Technical Research Centre of Finland (VTT). The working group has receiced ed opinions concerning the draft proposal and made some alterations to the draft programme. The Government approved this programme in its general session on 26 September 2002.
Keywords	Air pollution control, acidification, air quality, eutrofication, sulphur, nitrogen oxides, ammonia, volatile organic compounds, emissions, environmental policy, programmes, directives, Finland, EU
Publication series and number	The Finnish Environment 588e
Theme of publication	Environmental policy
Project name and number, if any	
Financier/ commissioner	Ministry of the Environment
Project organization	
ISSN 1238-7312	ISBN 952-11-1292-1 952-11-1293-X (PDF)
No. of pages 39	Language English
Restrictions Public	Price
For sale at/ distributor	Edita Publishing Ltd, Box 800, FIN-00043 Edita, Finland phone +358 20 451 05, telefax +358 20 450 2380 e-mail: asiakaspalvelu@edita.fi, www-server: http://www.edita.fi/netmarket
Financier of publication	Ministry of the Envronment
Printing place and year	Edita Prima Ltd, Helsinki 2002
Other information	Contact at the Ministry of the Environment, Seppo Sarkkinen phone +358 9 1603 9685 and Pasi Iivonen +358 9 1603 9491

Kuvailulehti

Julkaisija	Ympäristöministeriö	Julkaisuaika Lokakuu 2002
Tekijä(t)		
Julkaisun nimi	Air Pollution Control Programme 2010, National Programme for the Directive (2001/81/EU), approved by the Government on 26 September 2002 (Ilmansuojeluohjelma 2010, Valtioneuvoston 26.9.2002 hyväksymä ohjelma direktiivin 2001/81/EY toimeenpanemiseksi)	
Julkaisun osat/ muut saman projektin tuottamat julkaisut		
Tiivistelmä	Ympäristöministeriön 27.3.2002 asettaman työryhmän tehtävänä oli laatia ehdotus kansallisesta ohjelmasta päästöjen vähentämiseksi asteittain siten, että tiettyjen ilman epäpuhtauksien kansallisista päästörajoista annetun direktiivin (2001/81/EY) Suomen velvoitteet saavutetaan vuoteen 2010 mennessä. Kansallinen ohjelma sisältää tiedot politiikoista ja toimenpiteistä sekä määrälliset arviot näiden vaikutuksista päästöihin vuonna 2010. Työryhmä on koonnut arviot rikkidioksidin, typen oksidien , ammoniakin ja haihtuvien orgaanisten aineiden päästöistä vuonna 2010. Arvioiden pohjana on käytetty mm. kansallisen ilmastostrategian tietoja. Lisäksi on saatu uusinta tietoa arvioista, malleista ja skenaarioista SYKE:n ja VTT:n asiantuntijoilta. Työryhmä on hankkinut ohjelmaluonnoksesta lausunnot ja sen jälkeen viimeistellyt luonnoksen. Valtioneuvoston on hyväksynyt tämän ohjelman yleisistunnossaan 26.9.2002.	
Asiasanat	Ilmansuojelu, happamoituminen, ilmanlaatu, rehevöityminen, rikkidioksidi, typen oksidit, ammoniakki, haihtuvat orgaaniset yhdisteet, päästöt, ympäristöpolitiikka, ohjelmat, direktiivit, Suomi, EU	
Julkaisusarjan nimi ja numero	Suomen ympäristö 588e	
Julkaisun teema	Ympäristöpolitiikka	
Projektihankkeen nimi ja projektinumero		
Rahoittaja/ toimeksiantaja		
Projektiryhmään kuuluvat organisaatiot		
	ISSN 1238-7312	ISBN 952-11-1292-1 (nid.) 952-11-1293-X (PDF)
	Sivuja 39	Kieli Englanti
	Luottamuksellisuus	Hinta
Julkaisun myynti/ jakaja	Edita Publishing Oy, Asiakaspalvelu, PL 800, 00043 Edita puh. 020 450 05, telefax 020 450 2380 sähköposti: asiakaspalvelu@edita.fi, www-palvelin: http://www.edita.fi/netmarket	
Julkaisun kustantaja	Ympäristöministeriö	
Painopaikka ja -aika	Edita Prima Oy, Helsinki 2002	
Muut tiedot	Yhdyshenkilöt ympäristöministeriössä, Seppo Sarkkinen puhelin (09) 1603 9685 ja Pasi Iivonen puhelin (09) 1603 9491	

Presentationsblad

Utgivare	Miljöministeriet Datum Oktober 2002
Författare	
Publikationens titel	Air Pollution Control Programme 2010, National Programme for the Directive (2001/81/EU), approved by the Government on 26 September 2002 (Luftvårdsprogram 2010, Nationellt program för genomförande av direktivet 2001/81/EG, godkänt av Statsrådet 26.9.2002)
Publikationens delar/ andra publikationer inom samma projekt	
Sammandrag	Miljöministeriet tillsatte 27.3.2002 en arbetsgrupp med uppdrag att ställa förslag till ett nationellt program för successiv minskning av utsläppen så att Finland fram till år 2010 kan uppfylla sina skyldigheter enligt direktiv 2001/81/EG om nationella utsläppstak för vissa luftföroreningar. Det nationella programmet innehåller uppgifter om policyer och åtgärder samt kvantitativa uppskattningar om hur dessa inverkar på utsläppen år 2010. Arbetsgruppen har sammanställt uppskattningar av utsläppen av koldioxid, kväveoxider, ammoniak och flyktiga organiska föreningar år 2010. Dessutom har sakkunniga vid SYKE och VTT tillhandahållit färska rön om värden, modeller och scenarier. Arbetsgruppen har inhämtat utlåtanden om programutkastet och därefter lagt sista handen vid sitt förslag. Statsrådet har godkänt detta program vid sitt allmänna sammanträde 26.9.2002
Nyckelord	Luftvård, försurning, luftkvalitet, eutrofiering, svavel, kväveoxider,ammoniak, flyktiga organiska föreningar, miljöpolitik, program, direktiv, Finland, EU
Publikationsserie och nummer	Finlands miljö 588e
Publikationens tema	Miljöpolitik
Projektets namn och nummer	
Finansiär/ uppdragsgivare	Miljöministeriet
Organisationer i projektgruppen	
	ISSN 1238-7312 ISBN 952-11-1292-1 (nid.) 952-11-1293-X (PDF)
	Sidantal 39 Språk Engelska
	Offentlighet Offentlig Pris
Beställningar/ distribution	Edita Publishing Ab, Kundservice, PB 800, FIN-00043 Edita, Finland tel. +358 20 451 05, telefax +358 20 450 2380 e-mail: asiakaspalvelu@edita.fi, www-server: http://www.edita.fi/netmarket
Förläggare	Miljöministeriet
Tryckeri/ tryckningsort och -år	Edita Prima Ab, Helsinki 2002
Övriga uppgifter	Kontaktpersoner vid miljöministeriet, Seppo Sarkkinen tel. (09) 1603 9685 och Pasi Iivonen tel. (09) 1603 9491